Remarks

The specification has been amended to correct errors made during translation of the original Japanese specification into English and other obvious errors found in the specification. In particular, the paragraph on page 15, lines 19-24, has been amended to clarify that the minimum values of CTS referred to are from 10 test pieces welded by a welding current of CE or (CE + 1.5) kA, and that CE is a welding current immediately before expulsion and surface flash. The amended paragraph is a more accurate translation of the corresponding paragraph in PCT/JP2004/014790 on page 14, lines 12-16.

Claims 1-2 and 7-8 are pending in the application. In the Office Action mailed February 1, 2011, claims 1-2 and 7-8 are rejected. In the instant Amendment, claim 1 has been amended to clarify the recited CTS value. Support for the amendment is found in the specification at page 15, lines 6-27 (as amended).

No new matter has been added by these amendments. Entry of the foregoing amendment and consideration of the following remarks are respectfully requested.

Applicants' Interview Summary

Applicants wish to thank Examiner Mark Shevin for the courtesies extended to Applicant Mr. Yasuharu Sakuma and Applicants' representative Mr. Weining Wang for the interview conducted on June 27, 2011. During the interview, the present invention and its differences from the cited references U.S. Patent No. 6,364,968 ("Yasuhara"), Japanese Patent Publication 2000-080440 ("Tosaka"), and Japanese Patent Publication 2003-193194 ("Fujita"), and Marder, Vol. 20 of ASM Handbook (1997), pages 1 to 10 ("Marder") were discussed.

Applicant and Applicants' representative explained to the Examiner the background of the present invention, e.g., the importance of spot weldability of high strength steel sheet in automobile making. Specifically, the weld zone strength remarkably falls and becomes uneven when welding current enters the expulsion and surface flash region. Controlling welding current during spot welding to always below CE (which is the welding current immediately before expulsion and surface flash) is difficult. Fluctuations of welding current during spot welding cause decrease in weld zone strength and quality. The present invention

provides a high yield ratio high-strength cold-rolled steel sheet superior in spot weldability and ductility having a composition containing Si in a narrow range of 0.54 to 0.65%, further satisfying equation (1) below

$$1.1 \leq 14 \text{ x Ti } (\%) + 20 \text{ x Nb } (\%) + 3 \text{ x Mo } (\%) + 300 \text{ x B } (\%) \leq 3.7$$

with a microstructure 85 area% of lower bainite or bainitic ferrite. The steel sheet has a yield ratio of more than 0.64 to less than 0.90, a TS x (E1)½ of 3320 or more, an YR x TS x (E1)½ of 2320 or more, and a maximum tensile strength (TS) of 780 MPa or more, and a minimum value of CTS, which is a tensile load in a cross-joint test, of 0.8 or more among 10 values of CTS obtained by welding 10 test pieces at welding current CE + 1.5 kA, where CE is welding current immediately before expulsion and surface flash, when the minimum value of CTS among 10 values of CTS obtained by welding 10 test pieces by a welding current of CE is defined as "1". The steel sheet has an X-ray intensity ratio of a {110} plane parallel to the sheet surface at 1/8 the thickness of the steel sheet of less than 1.0.

Applicant and Applicants' representative then discussed with the Examiner the claim language and possible amendments to make the claim language clearer.[1]

Applicant and Applicants' representative also presented to the Examiner experimental data showing the correlation between spot weldability and formula (1), and explained to the Examiner that steel sheet of a composition having formula (1) below 1.1 exhibits poor spot weldability, while steel sheet of a composition having formula (1) above 3.7 exhibits poor elongation and ductility properties.

Applicant and Applicants' representative also presented to the Examiner experimental data showing the correlation between X-ray intensity ratio of a {110} plane and rolling conditions, and explained to the Examiner that cold-rolled steel sheet has this ratio less than 1.0, while hot-rolled steel sheet has this ratio higher than 1.0.

Applicant and Applicants' representative then discussed with the Examiner the differences between the present invention and Yasuhara, Tosaka, and Fujita, and explained to

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[1] During the discussion, the Examiner inquired about the steel property values that support the preamble recitation of "superior in ductility." Applicants respectfully point out that this recitation is supported by the requirement of TS x (E1)½ of 3320 or more (see the specification at page 19, lines 2-6).

the Examiner that none of Yasuhara, Tosaka, Fujita, and Marder teaches or suggests the present invention.

With respect to Yasuhara, Applicant and Applicant's representative explained that Yasuhara is concerned with a thin high-strength hot-rolled steel sheet having excellent stretch flangeability, not a cold-rolled steel sheet. Yasuhara's steel sheet is not subject to cold rolling. The skin-pass rolling of the hot-rolled sheet used in Yashuhara (Yasuhara col. 13, lines 61-63) is different from the cold rolling of the present invention (reduction ratio 30 to 80%; page 24, lines 31-33). A skin-pass rolling is also used on hot rolled steel sheet in present invention with a reduction ratio 4% (the present specification at page 20, lines 25-30). Yasuhara is not concerned with spot weldability in the expulsion and surface flash region. Yasuhara does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Yasuhara does not teach or suggest controlling alloy composition and formula (1). All examples disclosed in Yasuhara have a steel composition outside the present invention.

With respect to Tosaka, Applicant and Applicant's representative explained that Tosaka discloses a high-strength cold-roll steel sheet having ≥780 MPa tensile strength and ≥70 MPa amount of baking hardening, excellent stretch-flange formability, spot weldability, delayed fracture resistance, and impact resistance. However, Tosaka is not concerned with spot weldability in the expulsion and surface flash region. Tosaka does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Tosaka does not teach or suggest controlling alloy composition and formula (1). All examples disclosed in Tosaka have a steel composition outside the present invention. Tosaka also uses a different production method. For example, Tosaka teaches reheating the cast slab to a temperature giving undissolved Nb 0.003% or more, preferably 1150 °C or less, whereas in the present invention the steel slab is heated to 1160 °C or more, preferably 1200 °C or more, more preferably 1230 °C or more. Tosaka also employs rapid cooling from the annealing temperature to a temperature region of 350 °C to over 200 °C at a cooling speed of 15 to 150 °C/s, whereas in the present invention, the average cooling speed from 500 to 600 °C is 5 °C/s or more.

With respect to Fujita, Applicant and Applicant's representative explained that Fujita discloses a high strength, high ductility steel sheet having ≥800 MPa tensile strength and

improved weldability and hole expandability. However, Fujita is not concerned with spot weldability in the expulsion and surface flash region. Fujita does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Fujita does not teach or suggest controlling alloy composition and formula (1). All examples disclosed in Fujita have a steel composition outside the present invention. The production methods of Fujita and the present invention are also different. For example, in the present invention, the heating rate of 10 to 30 °C/s in the annealing after cold-rolling, while Fujita does not teach or suggest the heating rate. In addition, in the present invention, the cooling rate is 5 °C/s or more in the range of 500 to 600 °C, whereas Fujita teaches a cooling rate of 1 to 150 °C/s to 500 °C or less.

With respect to Marder, Applicant and Applicant's representative explained that Marder only discloses the common knowledge of hot dip coating, but does not disclose or suggest characteristic features of the relationship between the steel composition of the base steel sheet and spot weldability, nor the present production method or microstructure. Thus, Marder does not cure the deficiencies in Yasuhara or Tosaka.

The Examiner indicated that he understood the present invention and the differences between the present invention and the cited references, and suggested that Applicants file a Declaration under 37 C.F.R. §1.132.

<u>Rejection under 35 U.S.C. §112</u>

Claims 1, 2 and 7-8 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In particular, the Examiner states that the final paragraph of claim 1 is unclear. Applicants have amended claim 1 to clarify the recitation of the final paragraph. It is believed that the rejection is obviated by the amendments.

<u>Rejections under 35 U.S.C. § 103(a)</u>

Claims 1-2 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,364,968 ("Yasuhara"). The Examiner contends that it would have been obvious to a person skilled in the art, at the time of the invention, to produce the claimed steel sheets because Yasuhara discloses thin hot-rolled steel sheets of an overlapping steel composition,

produced by a substantially similar process, and having bainite as the main phase of not less than 90%.

The present invention provides a cold-rolled steel sheet having a combination of high yield ratio, high-strength, and superior in spot weldability and ductility. High strength steel sheet having good workability is important in many technical fields, including automobile making, e.g., automobile frame (see, e.g., the specification at page 1, line 20 through page 2, line 22). One of the most important properties of a steel sheet for use in such fields is its spot weldability. For example, the strength of the spot weld zone remarkably falls and becomes uneven when welding current enters the expulsion and surface flash region (see, e.g., the specification at page 1, lines 20-34; and page 3, lines 8-14). Controlling welding current during spot welding to always below CE (the welding current immediately before expulsion and surface flash) is difficult. Fluctuations of welding current during spot welding cause decrease in weld zone strength and quality. In addition, the yield ratio and workability such as ductility are also important (see, the specification at page 2, lines 7-22).

The steel sheet of the present invention is achieved by, *inter alia*, having a composition containing Si in a narrow range of 0.54 to 0.65%, satisfying equation (1) below

$$1.1 \leq 14 \text{ x Ti } (\%) + 20 \text{ x Nb } (\%) + 3 \text{ x Mo } (\%) + 300 \text{ x B } (\%) \leq 3.7,$$

and having a microstructure 85 area% of lower bainite or bainitic ferrite. The steel sheet has a yield ratio of more than 0.64 to less than 0.90, a TS x (E1)½ of 3320 or more, a YR x TS x (E1)½ of 2320 or more, and a maximum tensile strength (TS) of 780 MPa or more.

In addition, when the minimum value of CTS, which is a tensile load in a cross-joint test, among 10 values of CTS obtained by welding 10 test pieces by a welding current of CE, where CE is welding current immediately before expulsion and surface flash, is defined as "1", the steel sheet of the present invention has a minimum value of CTS of 0.8 or more among 10 values of CTS obtained by welding 10 test pieces at a welding current CE + 1.5 kA. The Declaration under 37 C.F.R. §1.132 submitted concurrently herewith ("the Declaration") shows the criticality of the steel sheets satisfying the recited formula (1). According to the Declaration, steel sheets of a composition having formula (1) below 1.1 exhibit poor spot weldability and yield ratio, whereas steel sheets of a composition having

formula (1) above 3.7 exhibit poor elongation and ductility. The Declaration also shows that when the steel sheet composition has a formula (1) below 1.1, the yield ratio is 0.59, outside the range of more than 0.64 to less than 0.90 as required by the claims.

The steel sheet also has an X-ray intensity ratio of a {110} plane parallel to the sheet surface at 1/8 the thickness of the steel sheet of less than 1.0. As Declaration shows, the X-ray intensity ratio of a {110} plane is less than 1.0 in cold-rolled steel sheets of the present invention, while higher than 1.0 in hot-rolled steel sheets. In the present invention, the X-ray intensity ratio of less than 1.0 for the cold-rolled steel sheets is necessary for achieving desirable formability (see the specification at page 14, lines 11-20).

In contrast, Yasuhara is concerned with a thin high-strength hot-rolled steel sheet having excellent stretch flangeability, not a cold-rolled steel sheet. Yasuhara's steel sheet is not subject to cold rolling. The skin-pass rolling of the hot-rolled sheet used in Yashuhara (Yasuhara col. 13, lines 61-63) is different from the cold rolling of the present invention (reduction ratio 30 to 80%; page 24, lines 31-33). A skin-pass rolling is also used on hot rolled steel sheet in present invention with a reduction ratio 4% (the present specification at page 20, lines 25-30). As Declaration shows, the presently claimed cold-rolled steel sheet has an X-ray intensity ratio of a {110} plane parallel to the sheet surface at 1/8 the thickness of the steel sheet of less than 1.0, while a hot-rolled steel sheet has such an intensity ratio higher than 1.0. Thus, the steel sheet of Yasuhara and the present invention are different in structure in this respect.

Furthermore, Yasuhara is not concerned with spot weldability in the expulsion and surface flash region. Yasuhara does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Yasuhara does not teach or suggest controlling alloy composition and formula (1) so as to achieve a steel sheet having the recited CTS in the expulsion and surface flash region. As the Declaration shows, all examples disclosed in Yasuhara have a steel composition outside the present invention.

Therefore, for at least the reasons presented above, Yasuhara does not render the presently claimed invention obvious. Accordingly, the rejection of claims 1-2 under 35 U.S.C. §103(a) over Yasuhara should be withdrawn.

Claims 1-2 are rejected under 35 U.S.C. §103(a) as being unpatentable over Japanese Publication No. 2000-080440 ("Tosaka"). The Examiner contends that it would have been obvious to a person skilled in the art, at the time of the invention, to produce the claimed steel sheets because Tosaka discloses a cold-rolled steel sheet of an overlapping steel composition and properties and produced by a substantially similar process.

Tosaka discloses a high-strength cold-roll steel sheet having ≥780 MPa tensile strength and ≥70 MPa amount of baking hardening, excellent stretch-flange formability, spot weldability, delayed fracture resistance, and impact resistance. However, Tosaka is not concerned with spot weldability in the expulsion and surface flash region. Tosaka does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Tosaka does not teach or suggest controlling alloy composition and formula (1) to achieve a steel sheet having the recited CTS in the expulsion and surface flash region. As the Declaration shows, all examples disclosed in Tosaka have a steel composition outside the present invention. Tosaka also uses a different production method. For example, Tosaka teaches reheating the cast slab to a temperature giving undissolved Nb 0.003% or more, preferably 1150 °C or less (Tosaka paragraph [0039]), whereas in the present invention the steel slab is heated to 1160 °C or more, preferably 1200 °C or more, more preferably 1230 °C or more (the specification page 23, lines 13-28). Tosaka also rapid cooling from the annealing temperature to a temperature region of 350 °C to over 200 °C at a cooling speed of 15 to 150 °C/s (Tosaka paragraph [0043]), whereas in the present invention, the average cooling speed from 500 to 600 °C is 5 °C/s or more (the specification at page 27, lines 4-8).

Therefore, for at least the reasons presented above, Tosaka does not render the presently claimed invention obvious. Accordingly, the rejection of claims 1-2 under 35 U.S.C. §103(a) over Tosaka should be withdrawn.

Claims 7-8 are rejected under 35 U.S.C. §103(a) as being unpatentable over Yasuhara or Tosaka in view of Marder, Vol. 20 of ASM Handbook (1997), pages 1 to 10 ("Marder").

As discussed in the previous response, Marder only discloses the common knowledge of hot dip coating. Marder does not disclose or suggest characteristic features of the relationship between the steel composition of the base steel sheet and spot weldability, nor

does Marder teach or suggest the present production method or microstructure. Thus, Marder does not cure the deficiencies in Yasuhara or Tosaka.

Therefore, claims 7-8 are not obvious under 35 U.S.C. § 103(a) over Yasuhara or Tosaka in view of Marder.

Claims 1-2 and 7-8 are rejected under 35 U.S.C. §103(a) as being unpatentable over Japanese Publication No. 2003-193194 ("Fujita"). The Examiner contends that it would have been obvious to a person skilled in the art, at the time of the invention, to produce the claimed steel sheets because Fujita discloses a high strength steel sheet of an overlapping steel composition and properties, having bainite of 70% or greater, and produced by a substantially similar process.

Fujita discloses a high strength, high ductility steel sheet having ≥800 MPa tensile strength and improved weldability and hole expandability. However, Fujita is not concerned with spot weldability in the expulsion and surface flash region. Fujita does not teach or suggest maintaining weld zone strength when welding with a welding current of the expulsion and surface flash region. Fujita does not teach or suggest controlling alloy composition and formula (1) to achieve a steel sheet having the recited CTS in the expulsion and surface flash region. As the Declaration shows, all examples disclosed in Fujita have a steel composition outside the present invention. The production methods of Fujita and the present invention are also different. For example, in the present invention, a heating rate of 10 to 30 °C/s is used in the annealing after cold-rolling (the specification at page 8, lines 3-6), while Fujita does not teach or suggest the heating rate. In addition, in the present invention, the cooling rate is 5 °C/s or more in the range of 500 to 600 °C (the specification at page 27, lines 4-8), whereas Fujita teaches a cooling rate of 1 to 150 °C/s to 500 °C or less (Fujita paragraph [0023]).

Therefore, for at least the reasons presented above, Fujita does not render the presently claimed invention obvious. Accordingly, the rejection of claims 1-2 and 7-8 under 35 U.S.C. §103(a) over Fujita should be withdrawn.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the present application is in condition for allowance. Early and favorable action by the

Examiner is earnestly solicited. If the Examiner believes that issues may be resolved by a telephone interview, the Examiner is invited to telephone the undersigned at the number below.

Respectfully Submitted,

Date: August 1, 2011

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